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GRAPEVINE LOOPER.

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INTRODUCTION.

The grapevine looper (*Lygris diversilineata* Hübn.)[1] is an insect enemy of the grapevine and Virginia creeper, causing injury by defoliating them. It is one of a group of leaf-feeding caterpillars known as geometrids, or measuring worms, of which the cankerworms are among the best known. It has been known as a grapevine pest for more than 70 years and occasional accounts of damage due to it have been published, but hitherto accounts of its biology and seasonal history, in particular, have been incomplete. The present paper is a record of studies of its biology and control, conducted at North East, Pa., in the Erie-Chautauqua grape belt during the seasons of 1916 and 1917.[2]

DISTRIBUTION.

The grapevine looper is found in northeastern United States and southern Canada. In the literature of the species its occurrence is noted from the following States: Massachusetts, New York, Illinois (*4*);[3] Maine, New Jersey, Pennsylvania, Michigan (*8*); Wisconsin (*10*); and Missouri (*18*). It has also been recorded from

[1] Order Lepidoptera, family Geometridae.

[2] The writer wishes to thank Mr. E. R. Selkregg for preparing abstracts of most of the literature cited herein, Mr. J. K. Primm for assistance in life-history studies in 1916, and Mr. J. H. Paine for preparing all illustrations except Plates III, A, and IV, B.

[3] Reference is made by number (italic) in parenthesis to "Literature Cited," p. 14.

Orilla, West Canada (*4*), and the provinces of Ontario and Nova Scotia (*15*). The writer has collected it in the States of New York, Pennsylvania, and Ohio.

FOOD PLANTS.

The grapevine was first recorded as a food plant of this species by Gueneé (*3*), and the Virginia creeper or woodbine by Saunders (*5*). Vaccinium was given by Gueneé as the food plant of his synonym *gracilineata* (*3*). Packard (*16*) published a note by Riley which lists as food plants the laurel, oak, elm, pear, apple, cherry, and the rose. This note states further that the larvæ entered the ground June 5, and adults emerged November 9. Since this differs so strikingly from the habits and duration of the pupal period of the species in question, it is obvious that Riley's observations relate to another species. The writer has observed it feeding on grapevines (*Vitis* spp.) and the Virginia creeper (*Parthenocissus quinquefolia*).

SYSTEMATIC HISTORY.

The grapevine looper was figured by Hübner in 1806 (*1*) as *Petrophora flava diversilineata* and later (*2*) was transferred by him to the genus Euphia. Gueneé (*3*) placed it in the genus Cidaria. This name is used interchangeably with Petrophora in practically all of the literature following until Dyar (*22*) listed it as *Eustroma diversilineata* Hübn., although Comstock (*19*) and Hulst (*20*) had previously used this nomenclature. Gumppenberg (*17*) placed both Petrophora and Cidaria in synonymy with Lygris, and listed the species as *L. diversilineata* Hübn. This nomenclature has been followed in the most recent check-list of North American Lepidoptera (*26*). The generic name has been spelled Petrofora (*10*), but this is undoubtedly a typographical error.

There is only one synonym of this species, *L. gracilineata* Gueneé (*3*). This was reduced to synonymy by Packard (*8*), but was later given rank as a variety by Grote (*11*).

SYNONYMY.

1806. *Petrophora flava diversilineata* Hübner (*1*).
1816. *Euphia diversilineata* Hübner (*2*).
1857. *Cidaria diversilineata* (Hübner) Gueneé (*3*).
1857. *Cidaria gracilineata* Gueneé (*3*).
1890. *Lygris diversilineata* (Hübner) Gumppenberg (*17*).
1895. *Eustroma diversilineata* (Hübner) Comstock (*19*).

COMMON NAME.

This insect was first called the "grapevine Cidaria" by Saunders (*12*) and because of the wide distribution of his general work on fruit insects this name is quite well known. After Cidaria became obsolete as the generic name, Lugger (*21*) called it "the grapevine Petrophora." This generic name has also been superseded. A name

descriptive of the larva, "the grapevine looper," was first applied by Fletcher (*15*) in 1887, and "the grapevine geometer" was the name used by Bethune (*24*) in 1907. Comstock (*19*) and Holland (*23*) used the name "diverseline moth." It would seem to the writer that the most serviceable name for an economic insect would be one descriptive of the destructive stage. For this reason he has followed Fletcher in using the name "grapevine looper." This is also the oldest name in use except that proposed by Saunders, which has become obsolete because of the change in the generic name.

ECONOMIC HISTORY.

The grapevine looper was first recorded as a pest of economic importance by Saunders (*6*) in 1870, and in following years was referred to by him and his colleagues as destructive in Ontario (*7, 12, 15, 24*). Damage done by this insect not only to hardy grapes but particularly to grapes under glass is recorded by Hoy (*10*). It is referred to as an economic insect in Illinois (*9, 13*), and is mentioned by Hartzell (*25*) in his report on grape insects in New York.

DESCRIPTION OF STAGES.

THE EGG.

The egg (Pl. I, A, B) is elongate ovate, with one end rounded and considerably wider than the other. The small end, which forms the micropyle, is flattened and has a scalloped rim encircling it. The shell surface is reticulate with irregular hexagonal areas, which are particularly conspicuous on the "rim" of the micropyle. The color is pale greenish yellow when first deposited, becoming lavender in about two days. Length 0.75 mm., greatest diameter 0.42 mm., diameter of micropyle 0.30 mm.

In a week or 10 days after the eggs are deposited they become somewhat depressed on the upper side. The shell is very durable and, even after the hatching of the egg, remains without breaking or shrinking for several weeks.

THE LARVA.

The larva (Pl. II) is very elongate and slender, the total length being about eighteen times greater than the greatest breadth. In general it is cylindrical, as tapering toward either end is slight. The head is flattened in front and strikingly bilobed dorsally, each lobe being bluntly pointed. The thorax and abdominal segments 7 to 10 are very short, while abdominal segments 1 to 6 are very long, making up three-fourths of the entire body length. The dorsal plate of the tenth segment is paraboloid, and two elongate processes from the ventral part of the segment protrude under it. Only the last two pairs of prolegs are present; the first of these, although belonging to the seventh segment, appears to arise between this segment and the sixth. This pair of prolegs is large and fleshy, while the pair arising from the tenth segment is wide, flat, and straplike.

The color is usually a pale green with pink or reddish markings. The extent of these markings varies and, while most frequently they are confined to the legs and a median ventral stripe, occasional larvæ are nearly all of some shade of red. Superficially the larva appears to be naked, but there are fine setæ on every segment.

Mature larvæ have a total length averaging 37 mm. and a head width averaging 2.05 mm.

Larvæ of all instars are practically alike in structure, except that the head is less distinctly bilobed in the earlier instars and not at all in the first instar.

THE PUPA.

The pupa (Pl. IV, A, B) is slender; its greatest width is at the thorax and it gradually tapers anally. The wing covers extend to the middle of the fourth segment. At the tip of the anal segment is a cremaster which bears four pairs of strong coiled hooks. The color is light green throughout, except the cremaster, which is flesh colored. Superficially the pupa appears to be naked, but under a high-power lens setæ are found on all segments except the last.

THE ADULT.

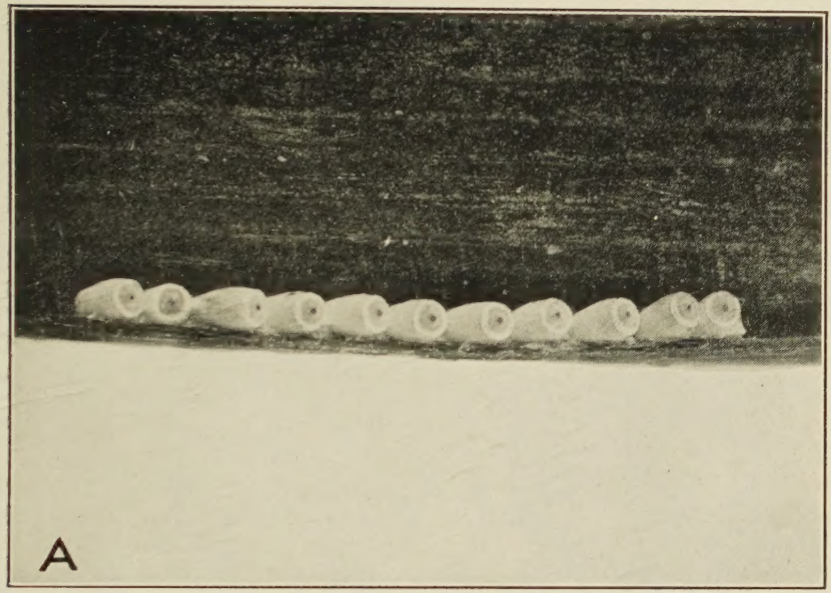
When Hübner (*1*) named this species he figured the adult (Pl. IV, C) in water colors, but gave no description. The following description of the adult is copied from Packard (*8*):

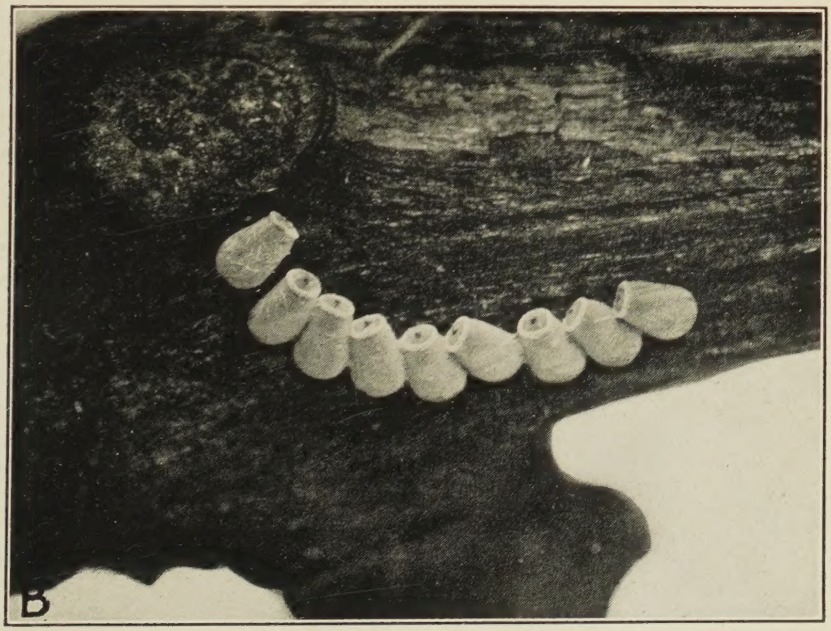
30 ♂ and 10 ♀.—Palpi long. Fore wings falcate; outer edge almost angular. Hind wings slightly scalloped. Body and wings of a uniform ochreous-yellow; palpi dark in front of the head, tipped with dark-brown. Fore wings uniformly ochreous; a curved, basal, rust-brown line, denticulated on the veins; beyond, two parallel, more distinct, concolorous lines, the inner a little wavy, directed obliquely to the inner edge; the outer makes a right angle in the submedian space, crosses the inner line, forming a broad, triangular enclosure on the inner edge of the wing; beyond is a broad space, just beyond the middle of the wing, usually filled in with a purplish-brown tint, disappearing before reaching the costal space; sometimes there are two central lines in this space, converging a little below the median vein and forming large ringlets; this mesial space is bounded externally by a dark, rust-brown line, which ends at the same distance from the base of the wing both on the costa and inner edge; in the first median space it forms a large, sharp projection; beyond is another concolorous line, which curves inward to where it is usually (not always) interrupted by the projection of the other line, and thence goes straight, though zigzag in its course, to the inner edge of the wing; a similarly colored more or less zigzag, oblique, apical line extends to the middle of the wing, opposite the projection; the edge beyond the lines either clear-yellow or filled in with lilac-brown; a small discal dot. Hind wings clear, a little paler than the fore wings, with a faint discal dot, sometimes absent; in the outer third of the wing an angulated, faint, violet-brown line, edged externally with silver, a heavier, diffuse, shorter, submarginal, dark-brown, zigzag line, with a slight violet tinge; the space between this and the wing suffused with violet-brown, extending only toward the middle of the wing, or sometimes passing beyond toward the apex. Beneath, the wings are yellow ochreous, speckled, especially on the hind pair, with coarse, violet-brown specks. Fore wings clear when covering the hind ones, with three costal spots, the third in the middle of the costa; beyond, the angulated outer line is reproduced; apical, oblique line distinct, with a violet-brown cloud below. Hind wings with three regularly-scalloped lines; the margin of the wing broadly clouded with violet-brown. Legs yellow; joints tipped with violet-brown. Abdomen yellow, tinged above with rust-brown.

Length of body, ♂ 0.60, ♀ 0.50–0.60 * * *; expanse of wings, ♂ 1.30–2.10, ♀ 1.35 inches.

LIFE HISTORY AND SEASONAL HISTORY.

The immature stages of this insect have been known since 1876 (*8*), but data regarding other biological phases have been meager and some misconceptions have arisen. Saunders (*6*) first sketched its seasonal history. He recorded the occurrence of larvæ in the





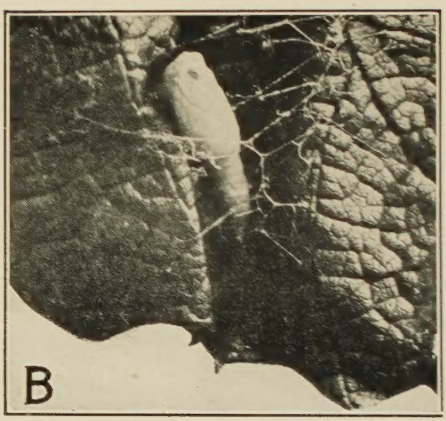
THE GRAPEVINE LOOPER.

Eggs on grape canes, showing (*A*) end view and (*B*) side view.

LARVA OF THE GRAPEVINE LOOPER.

WORK OF THE GRAPEVINE LOOPER.

A, Grape leaf being devoured by fifth-stage larva; *B*, grape leaf showing around edges typical feeding marks of early stages of the looper.



THE GRAPEVINE LOOPER.

A, Pupa, enlarged; *B*, pupa, in pupal web on grape leaf, enlarged; *C*, adult or moth, enlarged.

spring and of moths in June and August, and stated that *probably* eggs are deposited in the fall, produce larvæ which attain full growth before winter, and after hibernation "resume their destructive labors with the opening of spring." In the following years a number of authors repeat, without any qualification whatever, that the grapevine looper is two-brooded and hibernates as an immature larva. Forbes (*13*) recorded the collection of larvæ September 13 in southern Illinois and concluded that it is two-brooded in that latitude. Packard (*8*) stated that *perhaps* this insect is two-brooded in Texas, but he apparently regarded it as single-brooded farther north.

STUDIES AT NORTH EAST, PA., IN 1916.

Life-history studies of the grapevine looper really began in the summer of 1916, although miscellaneous observations had been made during the two preceding seasons. The attempt was first made to rear several hundred larvæ in battery jars, but with large numbers crowded together the mortality was very high. It was finally found best to isolate them in large shell vials. This method was followed altogether in the handling of larvæ in 1917, although it necessarily limited the number that could be studied. Adults were caged in battery jars.

The studies were begun with collected larvæ for the purpose of learning the duration of the pupal period and the time of emergence of moths and securing eggs for the next generation. These data are given in full in Table I.

TABLE I.—*Records of pupation and eclosion of moths of the grapevine looper, North East, Pa., 1916.*

Number of individuals.	Date of pupation.	Date of eclosion of adults.	Duration of period.	Number of individuals.	Date of pupation.	Date of eclosion of adults.	Duration of period.
			Days.				*Days.*
2	July 9	July 19	10	3	July 24	Aug. 3	10
1	9	20	11	1	25	3	9
2	10	20	10	3	25	4	10
1	12	22	10	1	25	5	11
1	16	25	9	1	26	4	9
1	17	26	9	6	26	5	10
1	18	27	9	4	27	6	10
1	18	28	10	3	28	7	10
1	20	30	10	1	28	8	11
3	22	31	9	1	29	7	9
1	22	Aug. 1	10	1	29	8	10
3	23	1	9	1	30	8	9
2	23	2	10				
2	24	2	9	48[1]			[2] 9.75

[1] Total. [2] Weighted average.

DURATION OF PUPAL PERIOD.

The pupal period of 48 individuals varied from 9 to 11 days, with an average of 9.75 days, as shown in Table I. The total period extended from July 9, the earliest record of pupation, to August 8, the latest record of eclosion of an adult.

ECLOSION OF MOTHS.

Transformation of pupæ to adults occurred during the period from July 19 to August 8, the majority of them having appeared by August 3. The dates of eclosion are shown in Table I.

HIBERNATION IN THE EGG STAGE.

By miscellaneous rearings in the season of 1915, the writer had learned that moths of this species appeared in midsummer, and according to most of the available information the insect was two-brooded. Consequently the eggs secured in cages were expected to produce a second generation in 1916. There proved to be only one generation, however. When the eggshells appeared to give way and the eggs became depressed (see description of egg), it was feared that they were infertile and a persistent search for second-brood larvæ in vineyards where the first brood had been abundant was begun. Not a single larva was found, nor did a single egg hatch that season, although it was shown by hatching records the following season that practically all of the eggs were fertile.

STUDIES AT NORTH EAST, PA., IN 1917.

The time of hatching of larvæ in 1917 and the time of occurrence and duration of the larval, pupal, and adult stages are given in Table II.

TABLE II.—*Dates of hatching and of occurrence and duration of stages of the grapevine looper, North East, Pa., 1917.*

Number of individuals.	Date of hatching.	Date of spinning cocoon.	Duration of feeding period.	Date of pupation.	Duration of prepupal period.	Date of eclosion.	Duration of pupal period.	Total duration of immature stages.
			Days.		*Days.*		*Days.*	*Days.*
1	June 2	July 17	45	July 19	2	July 29	10	58
1	2	21	49	23	2	Aug. 2	10	61
1	2	21	49					
1	2	25	53	July 27	2	Aug. 5	9	64
1	3	17	44	19	2	July 29	10	56
2	3	19	46	21	2	30	9	57
1	3	20	47	22	2	31	9	58
4	3	21	48	23	2	Aug. 2	10	60
1	3	22	49	24	2	3	10	61
1	3	24	51	26	2	5	10	63
1	3	25	52	27	2	6	10	64
1	4	18	44	21	3	July 30	9	56
1	4	19	45	21	2	30	9	56
2	4	21	47	23	2	Aug. 2	10	59
1	4	22	48	24	2	4	11	61
1	4	24	50	26	2	5	10	62
3	5	17	42	20	3	July 31	11	56
2	5	19	44	21	2	31	10	56
1	5	20	45	21	1	30	9	55
2	5	20	45	23	3	Aug. 1	9	57
1	5	21	46	23	2	2	10	58
1	5	23	48	24	1	2	9	58
1	5	23	48					
1	5	24	49	July 26	2	Aug. 5	10	61
2	5	25	50					
1	6	17	41	July 19	2	July 29	10	53
2	6	19	43	21	2	31	10	55
1	6	21	45	23	2	Aug. 1	9	56
1	7	20	43	22	2	1	10	55
1	7	21	44	23	2	2	10	56
2	7	22	45	24	2	4	11	58
1	7	23	46	24	1	1	8	55
1	7	23	46	24	1	2	9	56
2	7	24	47	26	2	Aug. 5	10	59
1	8	24	46	26	2	6	11	59
2	8	27	49	29	2			

TABLE II.—*Dates of hatching and occurrence and duration of stages of the grapevine looper, North East, Pa., 1917*—Continued.

Number of individuals.	Date of hatching.	Date of spinning cocoon.	Duration of feeding period.	Date of pupation.	Duration of prepupal period.	Date of eclosion.	Duration of pupal period.	Total duration of immature stages.
			Days.		*Days.*		*Days.*	*Days.*
1	June 9	July 20	41	July 21	1	July 31	10	52
1	9	21	42	24	3	Aug. 2	9	54
1	9	22	43	24	2	2	9	54
1	9	23	44	25	2	3	9	55
1	9	26	47	28	2	8	11	60
1	9	28	49	30	2	8	9	60
1	10	25	45	27	2	6	10	57
1	10	26	46	28	2	8	11	59
1	10	27	47	29	2	9	11	60
1	11	23	42	25	2	5	11	55
1	11	24	43	26	2	4	9	54
1	11	28	47	30	2	9	10	59
1	11	30	49	Aug. 1	2	12	11	62
1	11	31	50	1	1	12	11	62
1	13	26	45	July 28	2	7	10	57
1	14	26	44	28	2	8	11	58
1	15	27	44	29	2	8	11	57
1		10		13	3	July 24	9	
1		12		15	3	29	14	
1		13		16	3	27	11	
1		15		17	2	24	12	
1		20		22	2	Aug. 1	10	

TIME OF HATCHING.

The period of hatching of eggs in cages extended from June 2 to June 15, half of the larvæ having hatched by June 5. These dates are shown in Table II. Vineyard collections indicated that a few larvæ hatched fully a week earlier under natural conditions, for one newly molted larva of the second instar was collected June 2, and others collected in vineyards a little later were distinctly more advanced in development than those hatched in the insectary and matured about a week earlier. Vineyard observations showed, however, that the hatching period of the bulk of the brood is quite well covered by the insectary records.

DURATION OF LARVAL FEEDING PERIOD.

The duration of the larval feeding period, of 66 individuals reared, varied from 41 to 53 days with an average of 46.12 days. Records of the feeding period extended from June 2, date of the earliest recorded hatching, to July 31, date of the latest recorded spinning of the cocoon or pupal web. As previously stated, a few larvæ must have occurred in vineyards earlier than these records show. Compared with other leaf feeders on grapevines, this insect has an unusually long period for larval development, and consequently an unusually long period during which it may be destroyed by poison sprays.

TABLE III.—*Duration of the larval feeding period of the grapevine looper, North East, Pa., 1917.*

Number of individuals.	Duration of feeding period.
	Days.
2	41
5	42
5	43
8	44
10	45
7	46
7	47
7	48
8	49
4	50
1	51
1	52
1	53
[1] 66	[2] 46.12

[1] Total. [2] Weighted average.

DURATION OF FIRST LARVAL STAGE.

The duration of the first larval stage of 72 individuals reared varied from 8 to 12 days with an average of 9.19 days. These data are shown in Table IV. Records of this stage cover the period from June 2, the earliest recorded date of hatching, to June 24, the latest recorded date of passing the first molt.

TABLE IV.—*Duration of first larval stage of grapevine looper, North East, Pa., 1917.*

Number of larvæ.	Duration of stage.
	Days.
18	8
34	9
12	10
4	11
4	12
[1] 72	[2] 9.19

[1] Total. [2] Weighted average.

TABLE V.—*Duration of second larval stage of grapevine looper, North East, Pa., 1917.*

Number of larvæ.	Duration of stage.
	Days.
14	7
35	8
12	9
5	10
1	11
[1] 67	[2] 8.16

[1] Total. [2] Weighted average.

DURATION OF SECOND LARVAL STAGE.

The duration of the second larval stage, of 67 individuals reared, varied from 7 to 11 days with an average of 8.16 days. With the exception of one second-stage larva collected June 2, records on this stage extended from June 10, when the first larva passed the first molt, to July 2, when the latest larva passed the second molt. Data relating to the duration of this stage are summarized in Table V.

TABLE VI.—*Duration of third larval stage of grapevine looper, North East, Pa., 1917.*

Number of larvæ.	Duration of stage.
	Days.
1	6
7	7
16	8
24	9
12	10
3	11
4	12
[1] 67	[2] 8.95

[1] Total. [2] Weighted average.

DURATION OF THIRD LARVAL STAGE.

The duration of the third larval stage, of 67 individuals reared, varied from 6 to 12 days with an average of 8.95 days. These data are summarized in Table VI. The records on this stage extended from June 19, when the earliest larva passed the second molt, to July 11, when the latest passed the third molt.

DURATION OF FOURTH LARVAL STAGE.

The duration of the fourth larval stage, of 65 individuals reared, varied from 6 to 17 days, with an average of 9.71 days. These data are summarized in Table VII. The total period during which larvæ of this instar were recorded extended from June 26, when the earliest larva molted the third time, until July 19, when the latest larva molted the fourth time.

TABLE VII.—*Duration of fourth larval stage of grapevine looper, North East, Pa., 1917.*

Number of larvæ.	Duration of stage.
	Days.
4	6
10	7
6	8
13	9
10	10
10	11
2	12
6	13
2	14
1	15
1	17
[1] 65	[2] 9.71

[1] Total. [2] Weighted average.

TABLE VIII.—*Duration of feeding period of fifth larval stage of grapevine looper North East, Pa., 1917.*

Number of larvæ.	Duration of period.
	Days.
1	7
8	8
23	9
11	10
17	11
3	12
3	13
2	14
[1] 68	[2] 9.97

[1] Total. [2] Weighted average.

DURATION OF FIFTH LARVAL FEEDING STAGE.

The duration of the fifth larval feeding stage, of 68 individuals reared, varied from 7 days to 14 days, with an average of 9.97 days. The data are shown in Table VIII. This period includes all of the fifth stage except the period after spinning the cocoon, or the prepupal period. Records on the feeding period of larvæ of this instar extended from June 29 to July 31.

DURATION OF PREPUPAL PERIOD.

The duration of the prepupal period, of 68 individuals reared, or the time following the formation of the cocoon until pupation, is usually 2 days, although there are four records of 1 day and 10 of 3 days, as shown by Table II. This variation is not significant since observations were made only once a day, and it would be possible for an individual which required a little less than two days to have been noted only once during that time, or for one which required slightly more than two days to have been noted three times.

DURATION OF PUPAL PERIOD.

The duration of the pupal period, as shown by Table II, was practically the same as the preceding year, 63 of the 66 individuals under observation requiring 9 to 11 days, with an average of 10.18 days. The extremes, however, extended from 8 to 14 days. The records on

this period extended from July 13, the earliest recorded date of pupation, to August 12, the latest recorded date of eclosion of an adult—exactly the same length of time as recorded for 1916.

ECLOSION OF MOTHS IN 1917.

Eclosion of moths in 1917 extended from July 24 to August 12, with the height of the period about August 2. The dates of eclosion of moths reared are given in Table II.

SUMMARY.

There is one generation annually in the Erie-Chautauqua grape belt, winter being passed in the egg stage. Insectary records in 1917 show that eggs hatched from June 2 to June 15 inclusive. Field observations, while indicating that a few individuals may have hatched a week or more earlier, showed that the great majority of the eggs must have hatched during the first two weeks of June, confirming the insectary records. The hatching of larvæ in numbers occurred about three weeks before the grape blossoming period in 1917. The duration of the feeding period of most larvæ was from 6 to 7 weeks, averaging 46.12 days. Preparatory for pupation the larva secures itself by a loose web spun on a fold of a leaf or grape cluster. Two days are spent as prepupa and about 10 as pupa. The moth emerges in midsummer and deposits eggs which hatch the ensuing year.

It should be noted that the season of 1917 was a very late one, the grape blossoming period being about three weeks later than usual. It might be expected, therefore, that in a normal season the larvæ would hatch in considerable numbers in May and the earliest moths might even appear in June.

HABITS.

LARVAL HABITS.

As they hatch the larvæ eat out the micropyle and emerge from the egg, leaving the shell apparently as it was before. The newly hatched larvæ promptly migrate, scattering over the cane or vine on which the eggs happened to be placed. They are strictly solitary in habit and resent crowding. When two larvæ accidentally come in contact one is apt to strike viciously at the other, swinging its entire body in front of the prolegs like a whip and often knocking the intruder off the leaf. If both larvæ have a secure foothold a duel is apt to follow. In cages the writer has observed instances of cannibalism but this does not seem to be common. Because of this solitary habit seldom more than two or three are found on a single grape leaf. If crowded in cages the mortality is very high.

The grapevine looper progresses by the alternate measuring and looping movement characteristic of members of this group. It ex-

tends its long body to secure a foothold as far forward as possible and then looping the body upward brings forward its prolegs at the anal end of the body to secure footing immediately behind the thoracic legs. Among the earlier stages locomotion is very deliberate. The young larva precedes each forward extension of the body by raising the anterior part and swinging it in one direction or another as if to determine where the next step may safely be taken. In newly-hatched larvæ this preliminary movement is greatly exaggerated, and when a number of them migrate simultaneously along a cane they present a very ludicrous appearance, vigorously waving their long threadlike bodies to and fro before each looping movement.

The prolegs are the locomotor appendages most depended upon, and when the larva is stationary the thoracic legs are used but little. So muscular are the prolegs that one has difficulty in loosening their grasp upon a leaf-stem without causing injury to the larva itself. The larva may be made to fall if surprised when feeding, and when this is done, it seldom catches itself by a thread of silk as do the cankerworms.

When at rest or disturbed the older larvæ, in common with others of the group, have the habit of holding the body rigidly at an angle to the cane or stem on which they happen to be situated, depending entirely upon the prolegs for maintaining their hold. (Pl. II.) When in this position a larva may be mistaken for a grape tendril or leaf-stem, so that the habit is supposed to have some protective value. This habit is less characteristic of the younger larvæ, which when alarmed usually hold their body in a curved position instead of straight.

The dependence of the grapevine looper upon its prolegs for footing has modified its feeding habits, particularly in the earlier stages. Usually it grasps the edge of the leaf with its prolegs and extends its body over the upper surface toward the center of the leaf, eating the upper epidermis and parenchyma. As a result of this feeding habit a leaf attacked by one of these larvæ is marked by a series of whitish patches on the upper surface extending around the edge and about the same distance within. (Pl. III, B.) This characteristic location of the feeding marks readily distinguishes the work of this larva from that of any other pest of the grape with which the writer is familiar. However, if their position on the leaf is not taken into consideration the marks left by the small larvæ of the first instar may be mistaken for those of flea-beetles, while the large patches left by large larvæ might be mistaken for those of other grape-feeding Lepidoptera, as the eight-spotted forester (*Alypia octomaculata* Fab.) or beautiful wood nymph (*Euthisanotia grata* Fab.).

Larvæ of the fifth instar, and often of the fourth, feed at the edge of the leaf, stripping all but the stems and larger veins. (Pl. III, A.)

The time of this change in habit depends upon the texture of the leaf. It is in this stage that most of the damage is done.

The grapevine looper is largely crepuscular or nocturnal in its feeding habits. By day the majority of the larvæ hide on the underside of the leaves, holding to the midrib or larger leaf-veins. At this time of the day an inexperienced observer might have trouble finding many larvæ in a vineyard in which they were abundant. In the evening, however, just before dusk, practically all larvæ are feeding or moving from one leaf to another, and at this time they are readily found.

The larva does not make a cocoon, but spins a loose web (Pl. IV, B) which serves to hold the pupa in place. The pupal stage is passed in a leaf fold or in a grape cluster.

ADULT HABITS.

The moth is an active nocturnal flyer and is strongly attracted by electric lights. The writer has taken specimens at his desk lamp, which entered the room through an open window, and has frequently collected them at street lights. By day they rest on the underside of a leaf or cane and in this position have a curious habit of curling the abdomen dorsally so that it may nearly touch the dorsal surface of the head.

Oviposition occurs the day of emergence and may continue for two or three days, the length of life of the female. The number of eggs secured in cages from 22 females averaged 33.5 each. The moths oviposit readily in battery jars and are quite easily moved from one cage to another.

Eggs are deposited on their sides in more or less crescent-shaped rows of 8 to 12, the smaller ends being on the inner face of the crescent. Sometimes a second row is placed behind the first. In the vineyard they have been found only on the older vine growth and usually under strips of bark. In cages they may be placed almost anywhere, as on leaves and on the sides of the cages.

ECONOMIC IMPORTANCE.

The grapevine looper is a minor pest of the grapevine and as far as the writer has observed it has never caused serious injury except to grape arbors and garden vines. Of the minor pests which the writer has encountered in this region it is by far the most abundant, being present in much greater numbers than such well-known pests as the grapevine flea-beetle and the eight-spotted forester. It occurred in practically every vineyard, although in small numbers in those carefully sprayed for major pests. Its presence is usually unknown to the grower because of its habit of hiding by day and of the solitary habit which prevents conspicuous injury unless it is very abundant.

Even when partial stripping of the vines occurs it is usually attributed to some other cause. This insect should be regarded as a potential source of danger to the grape industry, which may at any time become destructive. It is also of importance in that its presence makes spraying to control the major pests of the vine more than ever advisable, since these measures incidentally hold it in check also.

CONTROL.

"Syringing" the vines with hellebore was the first remedial measure recommended (*6*) for the control of the grapevine looper. Since then the use of Paris green and arsenite of ammonia (*18*) have been recommended. These insecticides are now superseded by arsenate of lead, and this poison was used exclusively in experiments conducted at North East, Pa., during the season of 1917.

The amount of poison necessary to kill the grapevine looper was determined by spraying tests with various amounts. It was found that 1½ pounds of arsenate of lead, powdered (equivalent to 3 pounds of paste) to 50 gallons of liquid was the minimum strength that would kill larvæ in all stages. Small proportions of poison would kill very small larvæ, but since there are apt to be some large larvæ on the vines before defoliation is serious enough to attract attention, it would seldom be advisable to use a weaker solution.

The liquid used may be water, or Bordeaux Mixture if it is desired to control fungus diseases at the same time. The time of application can best be determined by the presence of the caterpillars.

As previously indicated, a spray application directed primarily against the grapevine rootworm and the grape-berry moth, immediately after the grape blossoms have fallen, incidentally controls the grapevine looper. In spite of the fact that some of the looper larvæ are well developed at this time, the poison is sufficient to destroy all stages of the pest and prevent it from becoming abundant the following season. It should be remembered, then, that work properly done to control the rootworm and berry moth also controls the grapevine looper without additional expense.

LITERATURE CITED.

(1) Hübner, Jacob.

1806. Sammlung exotischer Schmetterlinge. 4 p., 213 pl. Augsburg.

Page 4, pl. 206: *Petrophora flava diversilineata*. Four figures of adult male and female in water color.

(2) ———

1816. Verzeichniss bekannter Schmettlinge. 431+72 p. Augsburg.

Pages 336, no. 3234: *Euphia diversilineata*.

(3) Guenée, Achille.

1857. Uranides et Phalénites. t. 1. *In* Histoire naturelle des insectes. Spécies général des Lépidoptères, by J. A. Boisduval and A. Guénee. v. 9, 514 p., 11 pl. Paris.

Page 475: *Cidaria diversilineata*, description of adult, larva, and pupa, and life-history notes.

Page 476: *Cidaria gracilineata*, description.

(4) WALKER, FRANCIS.
1862. LIST OF THE SPECIMENS OF LEPIDOPTEROUS INSECTS IN THE COLLECTION OF THE BRITISH MUSEUM. pt. XXV, 5th ser. London.
Page 1389: *Cidaria diversilineata.*

(5) SAUNDERS, W.
1870. ON THE LARVÆ OF SOME LEPIDOPTERA. *In* Can. Ent., v. 2, no. 6, p. 74–76.

(6) ———
1870. ENTOMOLOGICAL GLEANINGS. Paper No. 2. *In* Can. Ent., v. 2, no. 9, p. 126–129.

(7) ———
1871. INSECTS INJURIOUS TO THE GRAPE. *In* Rept. Fruit Growers Assn. Ont. 1870, p. 94–117, figs. 31–52. Toronto.
Pages 103–105, fig. 43: *C. diversilineata.*

(8) PACKARD, A. S.
1876. A MONOGRAPH OF THE GEOMETRID MOTHS OR PHALÆNIDÆ OF THE UNITED STATES. 607 p., 13 pl. Washington. (*In* Rept. of the U. S. Geological Survey of the Territories, v. 10.)
Pages 126–128, pl. 8, figs. 53, 54: *Petrophora diversilineata.* Descriptions of adult and immature stages and notes on habits.

(9) FRENCH, G. H.
1878. ECONOMIC ENTOMOLOGY OF ILLINOIS. PART II. LEPIDOPTERA, OR BUTTERFLIES AND MOTHS, AND THEIR LARVA, OR CATERPILLARS. *In* Seventh Rept. State Entomologist Illinois, p. 135–273, figs. 32–48.
Page 237: *Petrophora diversilineata.*

(10) HOY, P. H.
1879. INSECTS INJURIOUS TO THE APPLE AND GRAPE. *In* Trans. Wis. Hort. Soc., v. 9, p. 230–241.
Page 235: *Petrofora diversilineata.* Note of injury to grapes.

(11) GROTE, A. R.
1882. NEW CHECK LIST OF NORTH AMERICAN MOTHS. 73 p. New York.
Page 50, no. 356: *P. diversilineata* Hübn. var. *gracilineata* Guenée.

(12) SAUNDERS, W.
1883. INSECTS INJURIOUS TO FRUITS. 436 p., 440 figs. Philadelphia.
Pages 270–271, figs. 279, 280: The grape-vine cidaria. Description of stages, habits, and destructiveness.

(13) FORBES, S. A.
1885. ON A FEW GRAPE INSECTS. *In* 14th Rept. State Entomologist on the Noxious and Beneficial Insects of the State of Illinois, 1884. Art. II, p. 83–86.

(14) BRUCE, DAVID.
1887. FOOD PLANTS OF GEOMETRIDÆ WITH OTHER NOTES. *In* Entomologica Americana, v. 3, p. 47–50.
Page 50: *P diversilineata.* Note on food plants.

(15) FLETCHER, JAMES.
1888. REPORT OF THE ENTOMOLOGIST AND BOTANIST (CANADA) FOR 1887. 41 p., 20 figs.
Page 35, figs. 17, 18: The grape-vine looper. Description with notes of destructiveness.

(16) PACKARD, A. S.
1890. INSECTS INJURIOUS TO FOREST AND SHADE TREES. U. S. Dept. Agr. 5th Rept. U. S. Ent. Comm. 955 p., 306 figs., 40 pl. (part col.). Washington.
Pages 189, 190, 282: *P. diversilineata.* Description as in (*8*) with additional notes on food plants.

(17) Gumppenberg, C. F.
1890. Systema Geometrarum zonæ temporatioris septentrionalis. Pt. 3, 163 p. (Nova acta der Ksl. Leop.-Carol. Deutschen Akademie der Naturforscher. Band 54, nr. 4., p. 271–431.)
Page (67): *Lygris diversilineata*. Synonymy. Notes compiled from Packard (*8*).

(18) Muttfeldt, Mary E.
1891. Entomological notes for the season of 1890. *In* U. S. Dept. Agr. Div. Ent. Bul. 23, p. 45–56.
Page 55: *Cidaria diversilineata*.

(19) Comstock, J. H., and Comstock, A. B.
1895. A manual for the study of insects. 701 p., 797 figs. Ithaca, N. Y.
Page 285, fig. 338: *Eustroma diversilineata*. Description and habits.

(20) Hulst, G. D.
1896. A classification of the Geometrina of North America, with descriptions of new genera and species. *In* Trans. Amer. Ent. Soc., v. 23, p. 245–386, pl. 10–11.
Page 278: *E. diversilineatum*.

(21) Lugger, Otto.
1898. Butterflies and moths injurious to our fruit-producing plants. Minn. Agr. Exp. Sta. Bul. 61, p. 55–334, 24 pl., 237 fig.
Pages 258–260, fig. 199: *P. diversilineata*.

(22) Dyar, H. G.
1902. A list of North American Lepidoptera and key to the literature of this order of insects. U. S. Nat. Mus. Bul. 52. 723 p. Washington.
Page 277: *E. diversilineata*. Synonymy.

(23) Holland, W. J.
1903. The moth book. 479 p., 263 figs. 48 col. pl.
Page 329, pl. 42, fig. 42: *E. diversilineata*.

(24) Bethune, C. J. S.
1907. Insects affecting fruit trees. Ont. Dept. Agr. Bul. 158. 36 p. 49 figs.
Page 31, fig. 46: The grape-vine geometer.

(25) Hartzell, F. Z.
1910. Preliminary report on grape insects. N. Y. (Geneva) Agr. Exp. Sta. Bul. 331, p. 485–581, 7 figs., 15 pl.
Page 493: The diverse-line moth.

(26) Barnes, W., and McDunnough, J.
1917. Check list of the Lepidoptera of Boreal America. 392 p. Decatur, Ill.
Page 104: *Lygris diversilineata*.

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